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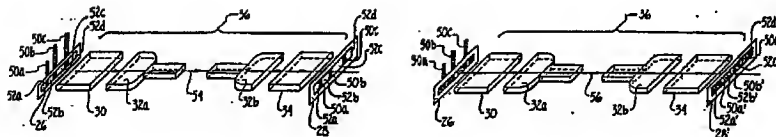
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(54) Title: HAIR ABLATION SYSTEM BY OPTICAL IRRADIATION



(57) Abstract

A shaving system which includes an apparatus for photoablating objects, such as hair, has an aperture (26) for framing the object (50) to be ablated. The shaving system also includes an optical system (36), a secondary light source (60) and a filter (28). In operation, whenever the secondary light source (60) is activated to illuminate the aperture (26) and object (50), the optical system (36) transfers light reflected from the object (50) and aperture (26) to the filter (28) which is located in the image plane of the optical system (36). In response to this reflected light, the filter (28) creates a negative of the object (50) and aperture (26). A laser source is then pulsed to radiate light through the negative filter (28), and onto the object, to photoablate the object.

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## HAIR ABLATION SYSTEM BY OPTICAL IRRADIATION

FIELD OF THE INVENTION

t The present invention pertains to shaving systems. More particularly, the present invention pertains to shaving systems which incorporate optical filters that  
5 selectively direct high intensity light into a field, but only onto the objects in the field which are to be photoablated. The present invention is particularly, but not exclusively, useful for shaving hair from the body surface of a person.

BACKGROUND OF THE INVENTION

10 Shaving hair from the body has been practiced by men and women since near the beginning of recorded time. Indeed., in many respects the instruments which are used today for this purpose still bear some rudimentary  
15 resemblance to the earlier shaving instruments. Specifically, both ancient shaving devices and modern day shaving devices have somehow generally included a sharpened edge, or blade; which is used to cut the hair close to the surface of the skin to give the person a shaven appearance.  
20 Over the years, improvements in shaving devices have been mostly the result of learning new and better ways to use more durable materials in the manufacture of longer lasting and sharper blades for the devices. Modern **technology,**  
25 **however, has taken us to the point where we are now looking for alternative ways to more efficiently and conveniently shave ourselves.** Such attempts, as is the case with the present invention, **have** focused on ways of severing hair from the body-which are quite different from merely cutting the hair with a blade.

f 30 It is **well** known that many materials can be altered by a process which is generally referred to as photoablation.' For photoablation, photons from a high intensity light source, such as a laser, are focused onto a material to alter the material in a way which causes it to be cut or  
35 severed.. This result may, of course, be beneficial for

diverse applications and the intent here is not to limit the present invention to a single such application. Instead, the present invention pertains to all applications where it is necessary and essential to carefully control  
5 the **photoablation process**. One specific instance **involves applications** where human tissue is to be cut or severed.

It happens that photoablation is quite effective as a procedure for altering human tissue. As implied above, however, where human tissue is involved it is essential to  
10 effectively control the photoablation process. In essence this means that the light used for photoablation needs to be carefully and accurately focused onto only the specific area or part of the material or tissue which is to be cut or severed. The present invention recognizes this can be  
15 accomplished by properly filtering the light which is used to photoablate the material.

Accordingly, it is an object of the present invention to **provide a device for photoablating** objects, such as human hair, which focuses sufficient light energy onto the  
20 object to cut or-sever the object. Another object of the present invention is to provide a device for photoablating objects which selectively focuses high intensity light only onto objects which are framed within a field. Still another object of the present invention is to provide a  
25 device for photoablating objects which filters or blocks unwanted energy from a high intensity light source to selectively direct light onto objects which are to be altered by photoablation. Yet another object of the present invention is to provide a device **for photoablating**  
30 **objects which is easy to use, relatively simple to manufacture and comparatively cost effective.**

#### SUMMARY OF THE INVENTION

In accordance with the present invention, a shaving device for photoablating hair includes a source of high  
35 intensity light, such as a laser, which is operationally

connected to the optical system of the device. This optical system includes an aperture, a filter device and an optical system. All of which may be mounted together in a housing.

5 When properly mounted, the optical system of the present invention is positioned between the aperture and the filter. More specifically, in relation to the optics established by the optical system, the aperture is located in the object plane, and the filter is located in the image  
10 plane. Consequently, when objects, such as strands of hair, are framed in the aperture, the picture composed by the object in the aperture is transferred through the optical system and onto the filter in the image plane.

The device of the present invention also includes a  
15 secondary light source which is positioned to illuminate objects as they are framed by the aperture and the filter. The picture which results from this illumination by the secondary light source is then transferred through the optical system as mentioned above, to the filter where a  
20 negative of the picture is created to effectively establish a negative filter. High intensity light, e.g. a laser light, is then directed from the high intensity light source, through the negative filter and onto the objects framed by the aperture.

25 In one embodiment of the present invention the filter device is an element having an image recording medium which, in-response, to light from the secondary source that is reflected by the object, establishes a negative of the picture. This embodiment can include a tertiary light  
30 source which radiates light at a wavelength that will erase the negative from the image recording medium of the filter. Alternatively, instead of a tertiary light source, a voltage source can be included which will erase the negative from the image recording medium at intervals as  
35 the picture changes. For another embodiment of the present invention, the filter device incorporates an image

processor which receives light from the secondary source that is reflected by the object to generate a signal which is representative of a negative picture. This signal is then used to impact the high intensity light source. In  
5 turn, the high intensity light source is programmed to accurately and selectively direct a beam of high intensity light onto only the objects that are to be photoablated.

In the operation of the particular embodiment for the present invention which uses an image recording medium as  
10 the filter, the secondary light source is first activated to create the negative at the filter, the high intensity light source is then activated to use the negative filter for directing light onto the object to be ablated, and the negative is then erased. This sequence can be repeated as  
15 necessary. In the operation of the embodiment of the present invention which uses an image processor as a filter, the secondary light source and the high intensity light source are alternately activated, as necessary.

For the particular application where the device of the  
20 present invention is to be used as a shaving system, the aperture can be mounted in a housing and the housing can be attached to a handle which can be used to move the aperture across the surface to be shaved. The optical system and the negative filter can also be mounted in the housing or,  
25 through the use of a suitable optical fiber system, can be mounted as a remote unit. Similarly, the various light sources can be remotely mounted as desired.

The novel features of this invention, as well as the invention itself, both as to its structure and its  
30 operation will be best understood from the accompanying drawings, taken in conjunction with the accompanying description, in which similar reference characters refer to similar parts, and in which:

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1A is a perspective view of the device of the present invention being used in an intended environment with a remote unit;

5        Figure 1B is a perspective view of an alternate embodiment of the device of the present invention in a cordless configuration without a remote unit;

      Figure 2 is a perspective view of the device;

10       Figure 3 is a cross sectional view of the housing of the device as seen along the line 3-3 in Figure 2;

      Figure 4 is a perspective view of an optical system for focusing light;

15       Figure 5 is a perspective view of the optical system of the present invention forming a positive photographic image;

      Figure 6 is a perspective view of the optical system of the present invention with the negative filter established for operational use with a high intensity light source;

20       Figure 7 is a schematic diagram of the operative components of the present invention for an embodiment which incorporates a voltage source to erase an image recording medium;

25       Figure 8 is a schematic diagram of the operative components of the **present invention for another embodiment which incorporates a tertiary light source to erase an image recording medium; and**

30       Figure 9 is a **schematic diagram of the operative** Components of the present invention for still another embodiment which incorporates an image processor.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring initially to Figure 1A, a device for photoablating an object is shown in an intended environment and is generally designated 10. As shown in Figure 1A, the

device 10 is being used to shave facial hair. This-  
application, however, is not limiting.

In Figure 1A, the device 10 is shown to include a  
razor 12 which is operatively connected by a cable 14 to a  
5 remote unit 16. Further, it can be seen that the remote  
unit 16 is formed with a cradle 18 which is formed to  
receive and hold the razor 12 when the razor 12 is not in  
use. With this device 10, a user 20 can remove the razor  
12 from the cradle 18 of remote unit 16, and activate the  
10 unit 16 to shave hair from a body surface. In an alternate  
preferred embodiment of the present invention, as shown in  
figure 1B, the device 10 is shown in a cordless  
configuration. In this alternate embodiment, the cable 14  
and remote unit 16 are eliminated and instead, all  
15 operative components of the device 10 are housed in the  
razor 12.

A more detailed view of the razor 12 of device 10 is  
presented in Figures 2 and 3. In Figure 2, specifically,  
it is shown that the razor 12 comprises a housing 22 and a  
20 handle 24 which is integrally attached to the housing 22.  
Although housing 22 is integral with the handle 24 for the  
embodiment shown in Figures 1-3, it will be appreciated  
that several forms of attachment between the housing 22 and  
the handle 24 can be established for the purposes of the  
25 present invention. Further, in Figures 1 and 2 the cable  
14 is shown to extend from the handle 24. Again, there can  
be several ways in which razor 12 is connected with the  
remote unit 16. Importantly, Figures 2 and 3 also show that  
the housing 22 is formed with an aperture 26 that is both  
30 long and narrow. Stated differently, the aperture 26 is  
formed as a slit which has great width and very little  
height.

The relationship between the housing 22 of razor 12  
and the operative optical elements of the device 10 are,  
35 perhaps, best shown in Figure 3. There it will be seen  
that the housing 22 is formed with an aperture 26 at its



front, and that a negative filter element 28 **is** positioned near the rear of the housing 22. As indicated in Figure 3, a series of lenses are positioned in the housing 22 for the purpose of transferring light between the aperture 26 and  
5 the negative filter 28. Specifically, this series of lenses includes, in sequence from the aperture 26 to the negative filter 28, a cylindrical lens 30, a **relay** lens 32 and a cylindrical lens 34. Together, the lenses 30, 32 and 34 comprise the optical system 36 of the device 10. A  
10 preferred configuration for this optical system 36 for the device 10 is best seen in Figures 5 and 6. When considering this configuration, it is to be appreciated that the relay lenses 32 can be positioned in any convenient arrangement which will effectively transfer  
15 light between the **cylindrical** lenses 30 and 34. For example, instead of positioning the negative filter 28 in the housing 22 of razor 12, it is conceivable that the negative filter 28 be positioned in the remote unit 16 of the device 10. The determining element in each case **will**  
20 be the configuration and composition of the relay lens 32. Regardless of the particular configuration for the relay lens 32, it is important for the operation of the device 10 that the optical system 36 be configured so that its object plane is coincident with the aperture 26 and its image  
25 plane is coincident with the negative filter 28.

Figure .4 illustrates a typical lens configuration whereby **high** intensity light, **such** as a laser, **can be** focused **for the purpose** of **photoablating an object**. For  
30 this illustrated configuration the light is shown linearly focused. Specifically, a beam of high intensity light 38 is first directed through a converging cylindrical lens 40. The converging cylindrical lens 40 then confines the beam 38 onto a transfer **element** 42. As is well known in the art, this transfer element 42 can be any suitable  
35 structure, such as an optical fiber system, which is capable of effectively transferring light from one point to

another. For the typical lens configuration being discussed, a dispersion lens 44 is shown to spread the light in beam 38 from the dispersion lens 44 and onto an elongated cylindrical lens 46. The cylindrical lens 46  
5 then linearly focuses the light to establish a cutting edge 48. For such a **configuration**, it is **possible** to **focus the** high intensity light beam 38 such that the **established** cutting edge 48 is **only** approximately one to two microns in thickness (1-2 microns), and has a depth of focus which is  
10 less than approximately one half millimeter (0.5 mm). For the purposes of the present invention, the optical system 36 incorporates similar optics.

Importantly for the present invention, depending on the direction in which light traverses the optical system  
15 36, the system 36 linearly **focuses** light on **either** the object plane at the aperture 26, or on the image plane at the **negative** filter 28. In order **to do** this, the cylindrical lenses 30 and 34 are located at the opposite ends of the optical system 36, as shown in Figures 5 and 6.  
20 As indicated above, the relay lenses 32a,b can be of any type well known in the art.

With a configuration as shown for the optical system 36 in the Figures 5 and 6, whenever aperture 26 is positioned against objects 50 a,b and c (for example, 'hair')  
25 the objects 50 a,b and c are framed by the aperture 26. This framing creates a picture which includes the objects 50. a,b and c, as well as the spaces 52 a, b, c and d that appear around the objects 50. This picture is then transferred through optical system 36 by light 54 to be  
30 **recomposed** on the image **plane** of **optical** system 36 at negative filter 28: **As will be appreciated by the skilled artisan**, a negative of the picture, as framed at the aperture 26, will invert **the dark and the light portions of the picture** to make **the picture** appear as shown at the  
35 negative filter 28' in **Figure 6**. More **specifically**, **objects 50 a,b and c which appear dark in aperture 26 will**

appear as light objects 50 a' , b' and c' at the negative filter 28'. **Conversely,- the light spaces 52 a,b,c and d** which appear at aperture 26 will appear as dark spaces 52 a',b',c'and d' at the negative filter 28'. The transformation of negative filter 28 into a negative of the **picture of the objects 50 a,b and c framed by aperture 26** can **be accomplished by** components known *in* the art, *in* a manner to be subsequently discussed. Suffice for the moment that the negative filter 28' can be created by the light 54 reflected from aperture 26 through the optical system 36.

OnCe the negative filter 28' has been established in response to the reflected light 54, high *intensity* light 56 can be directed through the filter 28' and focused by the cylindrical lens 30 of optical system 36 onto the objects 50 a,b and c. Importantly, due to the filtering effect which the negative filter 28' **has on** light 56, the light 56 will be blocked from passing. through the spaces 52 a,b,c and d at aperture 26 and will be focused on only the objects 50 a,b and .c. **Consequently,** when light 56 is focused in a manner as discussed above with reference to Figure 4, and depending on the wavelength of the light 56 and its ability to interact with the material of which the objects 50 a,b and c are composed, the objects 50 a,b and c will be **photoablated**.

Several structural embodiments for establishing the negative filter 28' and for directing high intensity light 56 onto the objects 50 a,b and c to be photoablated are contemplated for the device 10. For example, Figure 7 shows the schematic of an embodiment for device 10 wherein the filter 28 includes an image recording medium that is responsive to light 54 to create the negative filter 28'." Several media, such as a liquid crystal or solid crystal display of any type well known in the pertinent art, can be used for this purpose. Indeed, any reversible and erasable crystalline recording medium can be used for this purpose.-

For the particular embodiment shown in Figure 7 a high intensity light source 58 is provided as well as a secondary light source 60 and a voltage source 62. Also included is a beam splitter 64 which, as shown in Figure 7, can be incorporated into the structure of the optical system 36 in a manner well known in the pertinent art.

In the operation of the structural embodiment shown in Figure 7, light from the secondary light source 60, is directed along a light path 66 toward the beam splitter 64 where it is directed onto the optical axis 68 of the optical system 36 and toward the aperture 26. This light is then reflected from objects 50 a,b,c and aperture 26 as the light beam 54. For purposes to be subsequently discussed, the beam of light 54. has a wavelength that is different from that of the high intensity light 56. Furthermore, the wavelength of the light 54 must be properly selected to be capable of creating a negative at the filter 28'.

After filter 28' has been established by the light beam 54 which originated at secondary light source 60, the high intensity light source 58 is activated. With the activation of high intensity light source 58, high intensity light 56 is directed along a beam path 70 and through negative filter 28'. After being filtered at the negative filter 28' the high intensity light is passed along the optical axis 68 of optical system 36 to be focused through aperture 26 and into the cutting edge 48. With aperture 26 adjacent the objects 50, only those parts of cutting edge 48 are activated with focused high intensity light that coincides with the objects 50 a, b and c. The objects 50 are thus photoablated.

As shown in Figure 7, the voltage source 62 is connected via electrical conductor 72 with the negative filter 28. For this embodiment of the device 10, the voltage source 62 is appropriately activated to erase the negative filter 28' after secondary light source 60 is

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activated to establish the filter 28' and after high intensity light source 58 has used the negative filter 28' to direct high intensity light 56 onto only the objects 50. With the erasure of filter 28' the voltage source-62 prepares filter 28 for the creation of a new negative filter 28'. The new negative filter 28' will, of course, be characteristic of the new picture presented as aperture 26 is placed adjacent new objects 50. As indicated, secondary light source 60, high intensity light source 58 and voltage source 62 are each activated in the ordered sequence described above to photoablate the objects 50. The sequence can be repeated as necessary, and the time interval in each cycle during which high intensity light source 58 is activated is preferably less than ten milliseconds (10 msec).

For the embodiment of device 10 shown in Figure 7, both beam path 66 and beam path 70 can be made of an optical fiber system of any type well known in the pertinent art. Consequently, beam paths 66 and 70 can be combined with the electrical connector 72 as components of the cable 14 which connects remote unit 16 with razor-12. In this configuration, the high intensity light source 58, the secondary light source 60 and the voltage source 62 can be mounted in the remote unit 16. Of course, for the alternate embodiment of device 10 shown in Figure 1B, the same optical fiber system can be used with the high intensity light source 58, the secondary light source 60 and the voltage source 62 mounted on razor 12. This embodiment thus eliminates the need for cable 14 and remote unit 16. Indeed, as indicated above, the operative elements in each of the various embodiments for the device 10 can be mounted on razor 12.

In another embodiment of the present invention, as shown in Figure 8, a combined light source 74 is used which includes the high intensity light source 58 in combination with a tertiary light source. Again, an image recording

medium, such as the filter 28 is **used**. Also, the **secondary** light source 60 is still included, and it performs substantially the same function in substantially the same way as **disclosed** for the **secondary** light source 60 in  
5 Figure 7. The voltage source 62, **however**, is eliminated. Instead, the tertiary light source **of combined light source** 74 is used to erase the negative 28' to prepare filter 28 for the creation of a new negative filter 28'. Necessarily, the wavelength of light from the tertiary  
10 source must be different from the wavelengths of the light from both the secondary source 60 and the high intensity light source 58. Furthermore, while light from secondary source 60 must be capable of converting filter 28 into filter 28', light from the tertiary source must be capable  
15 of erasing the filter 28' and converting it back into the filter 28.

In the operation of the embodiment for device 10 as shown in Figure 8, the secondary light source 60 is activated to direct light 54 along the **optical axis 68** to  
20 establish negative filter 28'. High intensity light source 58 is then activated to direct the light beam 56 through the negative filter 28' and along optical axis 68 to be focused through aperture 26 onto cutting edge 48. Thus, only beams of light 56 which have passed through negative  
25 filter 28', and which therefore **correspond** with objects 50, will be focused onto cutting edge 48 to photoablate the objects 50. The tertiary light source is then activated to erase the filter 28' and the sequence is repeated as necessary. Preferably, the time **interval** during which high  
30 intensity light **source 58** is activated during **anyone cycle** of the sequence will be less than ten milliseconds (10 msec). Additionally, as will be appreciated by the skilled artisan, the high intensity light source 58 and the tertiary light source can be separated, rather than being  
35 integrated into the **combined** light source 74.

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Figure 9 shows yet another embodiment of the device 10 wherein the filter 28 comprises an image processor, such as a charge couple device well known in the pertinent art. For this embodiment, a microprocessor 76 is electrically  
5 connected to both the image processor of filter 28 via an electrical connection 78 and to a combined light source 80. In this instance, the combined light source 80 includes both the high *intensity* light source 58 and the secondary light source 60. Light from the combined light source 80  
10 is directed onto the optical axis 68 of optical system 36 via optical path 82 and a beam splitter 84. \_

In the operation of the embodiment shown in Figure 9, the combined light source 80 is energized to first activate the- secondary light source 60. As disclosed above, light  
15 54 from the secondary light source 60 establishes the negative filter 28'. The image processor of filter 28 then creates electrical signals that are representative of the negative filter 28' which corresponds to a picture of objects 50 framed by the aperture 26. Next, these signals  
20 are processed by the microprocessor 76 which, in- turn, activates the high intensity light source 58.. The resultant beam of high intensity light 56 from the combined light source 80 is configured to correspond with negative filter 28' and is passed through the optical system 36 to  
25 be focused onto cutting edge 48. Consequently, **because** the light 56 is configured to correspond with negative filter 28', the light 56 is focused on cutting edge 48 **only** where there are objects 50

In the operation of the embodiment shown in Figure 9,  
30 the high intensity light source 58 and the secondary light source of combined light source 80 are alternately activated by the microprocessor 76. Specifically, after secondary light source 60 has been activated to create the negative filter 28', the high intensity light source 58 is  
35 activated to generate a light beam 56 which corresponds with the negative filter 28'. With the light beam 56 the

objects 50 are photoablated. As implied, this sequence can be repeated as necessary or desired. Preferably, the time interval in each sequence during which high intensity light source 58 is activated is, as with the other  
5   embodiments disclosed above, less than ten milliseconds in duration (10 msec). Further, it will be appreciated by the skilled artisan that high intensity light source 58 **and** secondary light source 60 need not be combined into combined light source 80 but can, instead, be separated as  
10   desired.

While the particular device for photoablating objects as herein shown and disclosed in detail is fully capable of obtaining- ~~the~~ objects and providing the advantages herein before stated, it is to be understood that it is merely  
15   illustrative of the presently preferred embodiments of the *invention* and that no limitations are intended to the details of the construction or design. herein shown other than as defined in the appended claims.



I claim:

1. A device for photoablating an object which  
3 comprises:
  - a high intensity light source (58);
  - means for framing said object (26);-
  - 6 means for creating a negative of said framed  
object (28);
  - means for using said negative to filter light
  - 9 from said high intensity light source; and
  - means for directing said filtered light onto said  
object to photoablate said object (36).
2. A device as recited in claim 1 further comprising  
an optical system (36) positioned between said framed  
3 **object** (50) and said means for creating **a negative (28)** to  
present an image of said framed object at said means for  
creating a negative.

3. A device as recited in claim 2 wherein said negative creating means comprises:

3 a secondary light source (60) for radiating light  
at a selected wavelength, said selected wavelength  
being' different from the wavelengths of said high  
6 intensity light;

an image recording medium (28) responsive to  
light of said selected wavelength, radiated from said  
9 secondary source and reflected from said framed object  
(50) through said optical system (36), to create said  
negative according to said image; and

12 means for erasing said negative (62) from said  
image recording medium.

4. A **device** as recited in claim 3 wherein said image  
recording medium is a liquid crystal element.

5. A device as recited in claim 3 wherein said means  
for erasing said negative is a **voltage source** electrically  
3 connected with said image recording medium.

6. A device as recited in claim 3 wherein said means  
for erasing said negative is a tertiary light source for  
3 irradiating said negative with light of suitable wavelength  
and intensity to 'erase said negative.

7. A device as recited in claim 3 further comprising  
means (76) for selectively activating said high intensity  
3 light source during a time interval when said image  
recording medium establishes said negative.

8. A device as recited in claim 7 wherein said time  
interval is less than **approximately** ten milliseconds (10  
3 msec)'.

9. A device as recited in claim 2 wherein said negative creating means comprises:

3 a secondary light source (60) for radiating light at a selected wavelength, said selected wavelength being different from the wavelengths of said high intensity light;

6 an image processor (76) responsive to light of said selected wavelength, radiated from said secondary source and reflected from said framed object through said optical system (36), to create a signal representative of said negative according to said image; and

12 means for activating said high *intensity* source, said activating means being connected between said image processor and said high intensity light source, 15 to radiate high *intensity* light from said high intensity light source according to said signal.

10. A device as recited in claim 9 wherein said 'high intensity light source is pulse **activated-to** sequentially radiate high intensity light during predetermined time intervals.

11. A device as recited in claim 2 further comprising a housing (22); a handle (24) attached to said housing (22) 3 for manipulating said housing; and wherein said framing means is an aperture (26) mounted on said housing.

12. A device as recited in claim 11 wherein said optical system includes an optical fiber system to 3 **optically** couple said aperture with said negative creating means.

13. A device as recited in claim 12 wherein said object is body hair.

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14. A device as recited in claim 1 wherein said high intensity light source is a source of laser light.

15. A device for photoablating an object (50) which comprises:

- 3           a high intensity light source (58);  
          an aperture (26) positionable against said object  
          to establish a picture of said aperture and said  
6           object;  
          a filter (28), with means for establishing said  
          filter as a substantial equivalent to a negative of  
9           said picture; and  
          means (36) for directing light from said high  
          intensity light source, and through said filter, onto  
12          said object to photoablate said object.

16. A device as recited in claim 15 wherein said directing means includes an optical system positioned  
3   between said object and said filter to present an image of  
    said picture at said filter.

17. A device as recited in claim 16 wherein said means for establishing said filter as a negative of said  
3   picture comprises a secondary light source (60) for  
    radiating light at a selected wavelength, said selected  
    wavelength being different from the wavelength of said  
6   laser light; and wherein said filter (28) includes is an  
    image recording medium responsive to light of said selected  
    wavelength to create said negative according to said  
9   picture.

18. A device as recited in claim 17 further comprising a voltage source (62) and wherein said filter  
3   (28) is connected to said voltage source (62) to  
    selectively erase said negative from said image recording  
    medium.

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19. 'A device as recited in claim 17 further comprising a tertiary light source (80) and wherein said  
3 tertiary light source is positioned for irradiating **said**  
negative with light of suitable wavelength and intensity to  
erase said negative from said image recording medium.

20. A device as recited in claim 17 wherein said  
image recording medium is a liquid crystal element and said  
3 device further comprises means for selectively activating  
said laser source during a time interval less than  
approximately ten milliseconds (10 msec) while said liquid  
6 crystal element creates said negative.

21. A device as recited in claim 17 wherein said  
image recording medium is a reversible and erasable  
3 crystalline recording medium and said .device further  
comprises means for selectively activating said laser  
source during a time interval less than approximately ten  
6 milliseconds (10 msec) while said liquid crystal element  
creates said negative.

20

22. A device as recited in claim 16 wherein said means for establishing said filter as a negative of said

3 picture comprises:

a secondary light source (60) for radiating light at a selected wavelength, said selected wavelength  
6 being different from the wavelength of said high intensity light;.

an image processor (76) responsive to light of  
9 said selected wavelength, radiated from said secondary source and reflected as said picture through said optical system, to create a signal representative of  
12 said picture; and

means for activating said high intensity light source, said activating means being connected between  
15 said image processor and said high intensity light source, to radiate high intensity light from said high intensity light source according to said signal.

23. A device as recited in claim 22 wherein said high intensity light source is a laser source and is pulse

3 activated to sequentially radiate laser light during **predetermined** time intervals.

24. A method for photoablating an object which comprises the steps of:

- 3       providing a device comprising a high intensity  
-source (58); a secondary light source (60) for  
radiating light at a selected Wavelength, said  
6       selected wavelength being different from the  
wavelength of said laser light; an aperture (26)  
positionable against said object to establish a  
9       picture of said aperture and said object; a filter  
(28), with means for establishing said filter as a  
substantial equivalent to a negative of said picture;  
12      and means (36) for directing light from said high  
intensity light source, and through said filter, onto  
said object to photoablate said object;  
15      positioning said aperture against said object;  
activating said secondary light source to  
establish said filter as a negative of said picture;  
18      and  
activating said high intensity light source to  
direct light therefrom through said filter to  
21      photoablate said object.

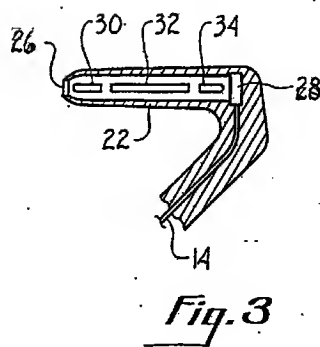
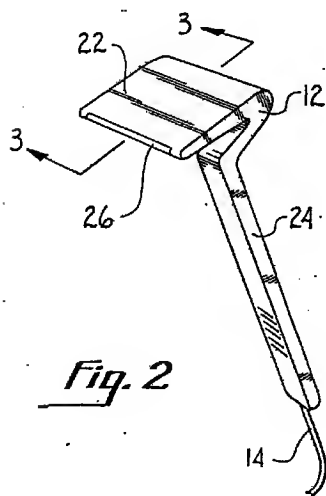
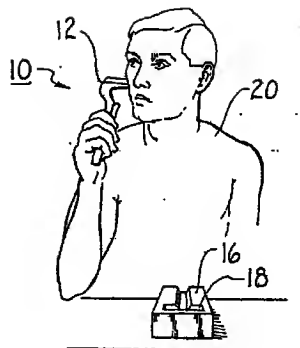
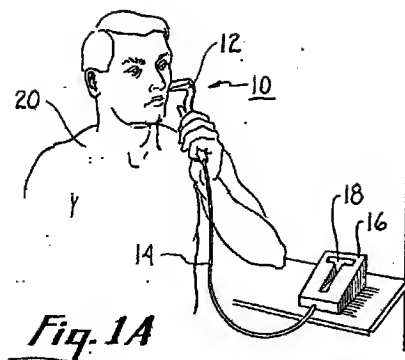
25. A method as recited in claim 24 wherein said  
means for establishing said filter includes an image  
3       recording medium (76) responsive to light of said selected  
wavelength to create said negative according to said  
picture, and an erasing means (62) connected to said image  
recording medium to selectively erase said negative from  
said medium, and wherein said method further comprises the  
step of sequentially cycling the steps of Activating said  
9       secondary light source, Activating said high intensity  
light source, and Erasing said negative from said image  
recording medium.

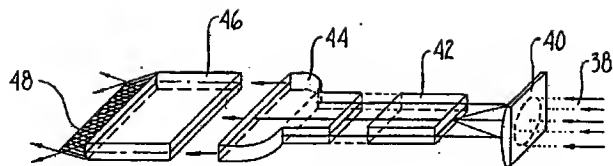
## 22

26. A method as recited in claim 24 wherein said means for establishing said filter includes an image  
3 processor responsive to light of said selected wavelength to create a signal representative of said picture, and  
means for **activating** said high *intensity* light **source, said**  
6 **activating means** being **connected between** said image processor and said high intensity light source, to radiate high intensity light from said high intensity light source  
9 according to said signal, and wherein said method further comprises the step of alternatingly activation said secondary light source and said high intensity light  
12 source.

27. A method as recited in claim 24 wherein said high intensity light source is a source of laser light.







//q.1

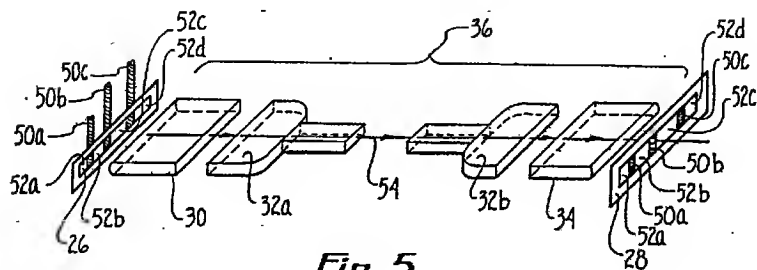


Fig. 5

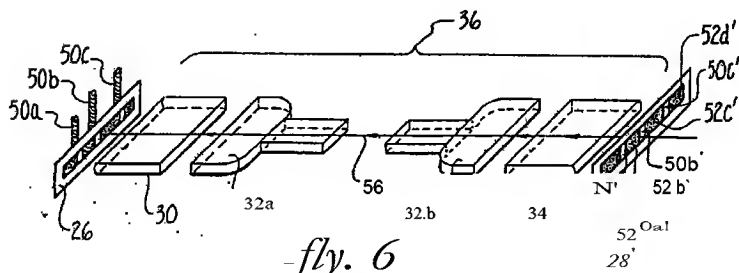
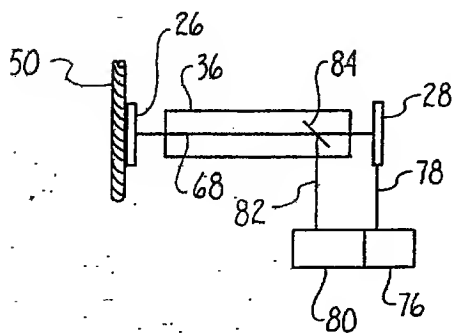
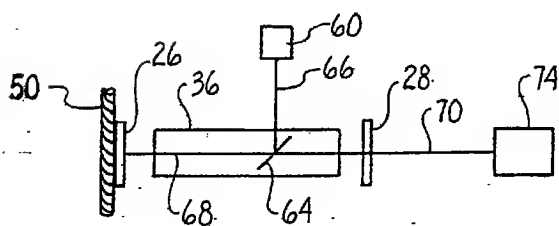
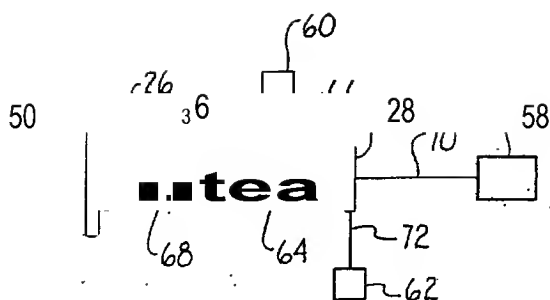


Fig. 6



# INTERNATIONAL SEARCH REPORT

PCT/US 92/06327

International Application No

## I. CLASSIFICATION OF SUBJECT MATTER Of several classification symbols apply, indicate at f:

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 B23K26/06; B23K26/00; A61B17/41

## II. FIELDS SEARCHED

### Minimum Documentation Searched<sup>d</sup>

Classification System

Classification Symbols

Int.Cl. 5 B23K ; A61B ; B26B

Documentation Searched other than Minimum Documentation  
to the Extent that such Documents are Included in the Fields Searched<sup>d</sup>

## ID. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup>

Category <sup>o</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>1a</sup>	Relevant to Claim No.
X	<p>GB,A,2 221 060 (INDUSTRIAL TECHNOLOGY RESEARCH INST.) 24 January 1990 see page 1, Line 1 - page 4, line 13 see abstract; claim 1; figure 1</p> <p>US,A,4 978 830 (M.A. MILLERICK ET AL.) 18 December 1990 see column 2, line 30 - line 44 see column 2, line 61 - column 3, line 25 see column 3, line 28 - line 37 see column 4, line 19 - line 26 see abstract; claims 1-3,6,7,16; figures 1-6</p>	I 2-27

<sup>1</sup> Special categories of cited documents : ro

<sup>A'</sup> document defining the general state of the art which is not considered to be of particular relevance  
earlier document but published on or after the international filing date

If document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

<sup>O'</sup> document referring to an oral disclosure, use, exhibition or other means

<sup>\*</sup> document published prior to the international filing date but later than the priority date claimed

<sup>\*</sup> later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

<sup>\*</sup> document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step  
document of particular relevance\* the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.\*

<sup>&</sup> document member of the same patent family

## IV...CERTIFICATION

Date of the Actual Completion of the International Search

Date of Mailing of this international Search Report

25 JANUARY 1993

0 02. 93

International Searching Authority

Signature of Authorized Officer

EUROPEAN PATENT OFFICE

HAEGERMAN M.

W. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category	Citation of Document, with Indication, where appropriate, of the relevant passages	Relevant to Mint No.
A	EP,A,0 125 692 (NEC CORPORATION) 21 November 1984 see page 3, line 1 - page 5, line 7 see page 7, line 6 - line 20 see abstract; claims 1-12; figures 1-11	1 2-27
	WO,A,9 106 406 (SIMON) 16 May 1991 see page 1, line 26 - line 37 see page 2, line 23 - line 34 see abstract; claim 1;-figures 1-4	1-27

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO.**

**US 9206327  
SA 63298**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

**25/01/93**

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US-A-4978830	18-12-90	JP-A- 2247090 US-A- 5099101	02-10-90 24-03-92
EP-A-0125692	21-11-84	JP-A- 59211016 JP-A- 60027490 US-A- 4734558	29-11-84 12-02-85 29-03-88
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